(A) One way ANOVA table:- (Single factor ANOVA)

It is convenient to summarize the result of an analysis of variance in a table.

Source of variation	Sum of Square (SS)	DOF	Mean Square MS	F-Ratio
Between Samples	SS_B	$K-1$	$MS_B = SS_B/DOF_B$	MS_B/MS_W
Within Sample	SS_W	$n-K$	$MS_W = SS_W/DOF_W$	
Total	SS_T	$n-1$		

(Qn)

X_1	X_2	X_3
1	2	2
2	4	3
5	2	4

Ans

Step-1: $H_0 : \mu_1 = \mu_2 = \mu_3$

$H_a : \mu_1 \neq \mu_2 \neq \mu_3$

$\alpha = 0.05$

Step-2: Dof between $= (k-1)$

where, k = No of groups

So, $k = 3$ // , $3-1 = 2$ //

Dof within $= (n-k)$, where n = No of scores

$n = 9$

So, $(n-k) = (9-3) = 6$ //

Dof Total $= (n-1)$ Co. $(9-1) = 8$ //

Table value (Refer the table)

Dof between ⟶ Numerator

Dof within ⟶ Denominator

So Table value $= 5.14$ //

Step-3:

X_1	X_2	X_3	X
1	2	2	1
2	4	3	2
5	2	4	5
			2
			4
			2
			2
			3
			4
$\sum X_1 = 8$	$\sum X_2 = 8$	$\sum X_3 = 9$	$\sum X = 25$
$\bar{X}_1 = 8/3$	$\bar{X}_2 = 8/3$	$\bar{X}_3 = 9/3$	$G\bar{X} = 25/9$
$= 2.67$	$= 2.67$	$= 3$	$= 2.78$

Step-4: (I) Calculate Sum of Square Total (SS_T):-

SST = Sum Square $(x_i - G\bar{x})$ of Sum of Square Total $(x_i - G\bar{x})^2$

x_1	x_2	x_3	SS_T
$(1-2.78)^2$ = 3.16	0.60	0.60	3.16 + 0.60 + 4.94 + 0.60 + 1.49 + 0.60 + 0.60 + 0.05 + 1.49 // 13.56
$(2-2.78)^2$ = 0.60	1.49	0.05	
$(5-2.78)^2$ = 4.94	0.60	1.49	

(II) Calculate Sum of Square within (SS_W):-

SS_W = Sum of Square $(x_i - \bar{x}_i)$ of Sum of Square within $(x_i - \bar{x}_i)^2$

x_1	x_2	x_3	SS_W
$(1-2.67)^2$ = 2.78	$(2-2.67)^2$ = 0.444	$(2-3)^2$ = 1	2.78 + 0.444 + 5.444 + 0.444 + 1.78 + 0.444 + 1 + 0 + 1 // 13.33
0.444	1.78	0	
5.444	0.444	1	

(III) Calculate Sum of Square between (SS_B)

$SS_B = SS_T - SS_W = 13.56 - 13.33 = 0.22$

Step-5 :- Calculate Mean Variance

(I) Mean Square between (MS_B)

$\Rightarrow MS_B = SS_B / DOF_B = 0.22/2 = 0.11$

(II) Mean Square within (MS_W)

$\Rightarrow MS_W = SS_W / DOF_W$

$= 13.33/6 = 2.22$ //

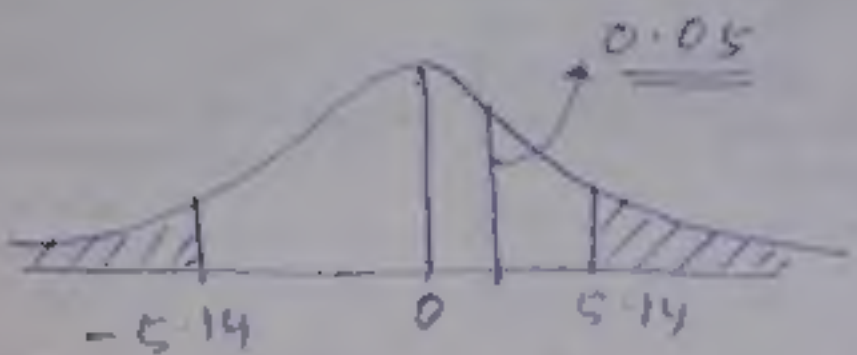
Step-6 Calculate f. Ratio:-

$$f = MS_B / MS_W = 0.11 / 2.22 = 0.05$$

critical factor of f value from the table = 5.14

Conclusion:-

Calculated value < Table value



0.05 < 5.14

Hence Ho fails to reject i.e, Ho is accepted.

So there is no significant difference between all the variables of three different series.

(B) Two way ANOVA table:-

(Two factor analysis)

It takes the following form.

Source of variance	Sum of Square (SS)	DOF	Mean Square (MS)	F Ratio
Between Row	SS_R	$(r-1)$	$MS_R = SS_R / DOF_r$	$\frac{MS_R}{MS_E}$
Between Column	SS_C	$(c-1)$	$MS_C = SS_C / DOF_c$	$\frac{MS_C}{MS_E}$
Error / Residual	SS_E	$(r-1)\times[(c-1)]$	$MS_E = SSE / DOF_c$	
Total	SS_T	$(rc-1)$		

Ex

Fertilizers ↓ / Seeds →	a	b	c
W	6	5	5
X	7	5	4
Y	3	3	3
Z	8	7	4

Step-1 Calculate Correction factor:-

Correction factor = T^2/N

where, T = Sum of all values

$(6+7+3+8+5+5+3+7+5+4+3+4) = 60$

$N = R \times C = 4 \times 3 = 12$

Correction factor = $(60)^2/12 = 300$ //

Step-2 Calculate Sum of Square Total (SS_T):-

SS_T = (Total Sum square − Correction factor)

	a	b	c
w	36	25	25
x	49	25	16
y	9	9	9
z	64	49	16

Total Sum square = 332

$SS_T = 332 - 300 = 32$ //

Step-3 Calculate SSc SSR & SSR

	a	b	c	TR	TCR = CSR/ni
w	6	5	5	16	$16^2/3 = 85.33$
x	7	5	4	16	$16^2/3 = 85.33$
y	3	3	3	9	$9^2/3 = 27$
z	8	7	4	19	$19^2/3 = 120.33$
Sc	24	20	16	////////	SCR (317.66)
$SSc = Sc^2/ni$	$24^2/4 = 144$	$20^2/4 = 100$	$16^2/4 = 64$	SSc = (308)	

Step-4

(i) Calculate SS between Column treatment:-

$= SS_c - \text{Correction factor}$

$= 308 - 300 = 8$ //

(ii) Calculate SS between Row treatment:-

$= SS_R - \text{Correction factor}$

$= 317.66 - 300 = 17.66 = 18$ //

(iii) Calculate SS residual & Error:-

$= SS_T - (SS_c + SS_R)$

$= 32 - (8 + 18) = 6$ //

Step-5

ANOVA Table

Source of Variation	SS	DOF	MS	F-ratio
Between Row	18	$(4-1) = 3$	$18/3 = 6$	$6/1 = 6$
Between Column	8	$(3-1) = 2$	$8/2 = 4$	$4/1 = 4$
Residual Error	6	$3 \times 2 = 6$	$6/6 = 1$	
Total	32	$(6 \times 2) - 1 = 5$		

N.B:- Critical value (Refer to table)

D.of of (Row, Residual Error) are numerator & denominator respectively as well as (Column, Residual Error) are also numerator & denominator respectively. ie $F(2,6) = 5.14$ // & $F(3,6) = 4.76$ //

Decision :-

Column :-

Hence f-value calculated in terms of between column < critical value of column

$\Rightarrow 4 < 5.14$

Hence Ho fails to reject (Ho accepted)

So there is no significant difference between seeds.

Row :-

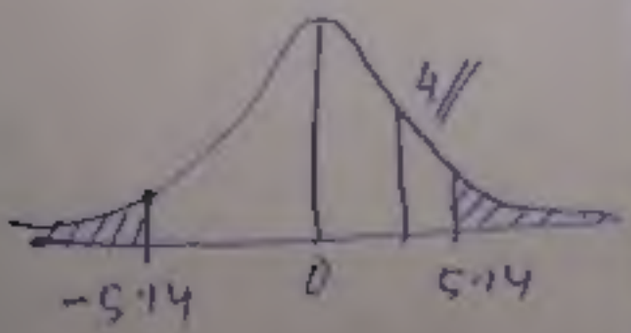
Hence f-value calculated in terms of row > critical value of row

$\Rightarrow 6 > 4.76$

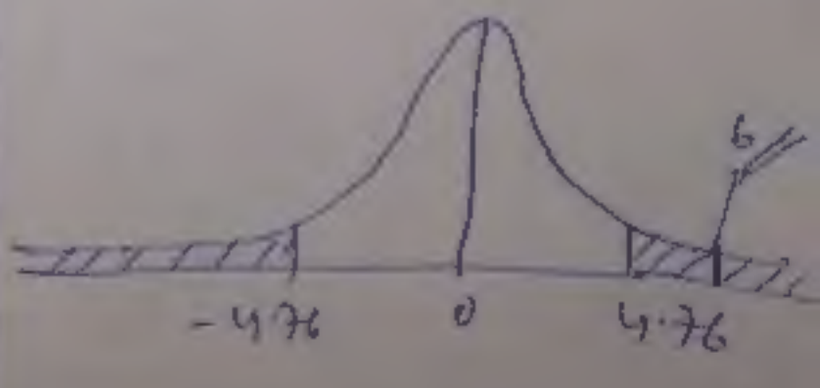
Hence Ho is rejected

So there is significant difference between the fertilizers

(Seeds) (Fertilizers)



Accepting Ho



Rejected Ho

The F - Distribution with $\alpha = 0.05$								
$\nu_2 \backslash \nu_1$	2	3	4	5	6	7	8	9
2	19.00	19.16	19.25	19.30	19.33	19.35	19.37	19.38
3	9.55	9.28	9.12	9.01	8.94	8.89	8.85	8.81
4	6.94	6.59	6.39	6.26	6.16	6.09	6.04	6.00
5	5.79	5.41	5.19	5.05	4.95	4.88	4.82	4.77
6	5.14	4.76	4.53	4.39	4.28	4.21	4.15	4.10
7	4.74	4.35	4.12	3.97	3.87	3.79	3.73	3.68
8	4.46	4.07	3.84	3.69	3.58	3.50	3.44	3.39
9	4.26	3.86	3.63	3.48	3.37	3.29	3.23	3.18